








Original Article



Surgical Strategies for Partial Breast Reconstruction in Medial-Located Breast Cancer: A 12-Year Experience

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ABSTRACT

Purpose: Partial breast reconstruction is challenging in medially located breast cancer, particularly in terms of achieving satisfactory aesthetic coverage. Thus, we aimed to investigate surgical strategies for filling medial defects resulting from breast-conserving surgery to improve patient satisfaction and aesthetic outcomes.

Methods: We retrospectively evaluated 113 patients (114 cases) with medially located breast cancer between 2007 and 2018. We analysed the patient data, such as breast size, specimen weight, complications, and aesthetic results obtained using a questionnaire.

Results: The mean body mass index and specimen weight were 23.43 kg/m² (range, 18.5–26.8) and 83.29 g (range, 15–290 g), respectively. The tennis racket and round-block techniques were chosen for small defects (< 10%–15%) in small- and medium-sized breasts. The rotational and perforator flap techniques were used for medium-sized defects. The latissimus dorsi (LD) flap technique was used for large defects (> 30%). Hematoma was found in 1 case (0.96%), linear skin necrosis was found in 1 case (0.96%), seroma in the LD flaps was found in 8 cases (7.69%); fat necrosis in the rotational flaps was found in 2 cases (1.92%); and fat necrosis in an anterior intercostal artery perforator flap was found in 1 case (0.96%). 91 patients (87.5%) were satisfied with the aesthetic results.

Conclusion: The techniques used in this study for medially located breast cancer can produce fine aesthetic outcomes with regard to breast size and resection volume, with few complications.

Keywords: Breast Neoplasms; Mastectomy, Segmental; Mammoplasty; Perforator Flap

INTRODUCTION

Recent improvements in diagnostic techniques and frequent use of periodic screening tests such as sonography and mammography have allowed the early diagnosis of breast cancer, which can be treated with breast-conserving surgery (BCS) rather than total mastectomy [1]. Therefore, interest in oncoplastic surgery after BCS is increasing. Numerous oncoplastic techniques have improved aesthetic outcomes [2,3]. Tumour location, breast size, and defects have been considered significant factors for selecting the oncoplastic technique in several studies [4,5]. However, only a few studies have evaluated the application of BCS for

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Conceptualization: Yang JD; Data curation: Eo PS, Hong HK; Formal analysis: Lee JW, Kang MJ; Methodology: Lee JS, Lee J, Kang MJ; Supervision: Park HY; Writing - original draft: Kang MJ, Hong HK; Writing - review & editing: Yang JD.

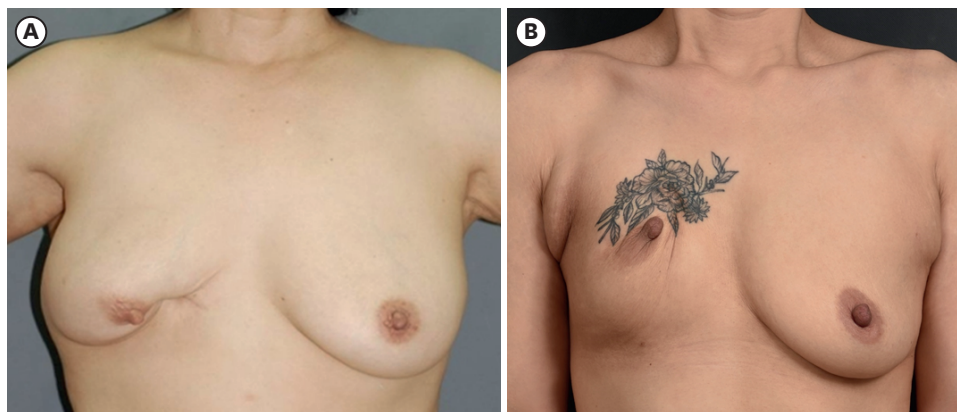


Figure 1. A photograph of a patient who did undergo an appropriate breast reconstruction after breast-conserving surgery for a medially located breast cancer. (A) A patient with breast cancer in the lower inner quadrant. (B) A patient with breast cancer in the upper inner quadrant.

breast cancers in the upper and lower medial quadrants, which comprise 20% of all breast cancer cases [6-8].

Surgery without reconstruction for medially located breast cancers can result in unsatisfactory outcomes. Oncoplastic surgery, even when performed, can result in deformities due to lack of skin and glandular tissues, or medial shifting and an unnatural location of the nipple-areola complex (NAC) [9]. NAC displacement or conspicuous scarring can occur easily in the upper inner quadrant, and the optimal oncoplastic technique is difficult to determine. This location is referred to as a no-man's-land [9]. Both the upper and the lower inner quadrant have no supporting tissue inferiorly, which can lead to poor outcomes (**Figure 1**) [10]. Although the incidence of breast cancer in the upper and lower medial quadrants is almost one-fifth of all breast cancer cases and subsequent treatment in this location can be challenging, no corresponding surgical technique has been established. Waljee et al. [11] predict greater asymmetry after superior medial and inferior lateral tumour resection for breast cancer, thus there is much to consider for the reconstruction on those quadrants.

Kronowitz et al. [5] introduced reduction mammoplasty as a surgical technique for each quadrant, Munhoz et al. [12] discussed volume replacement surgical techniques for medium-sized defects in the central and medial quadrants, and McCulley et al. [13] introduced the free transverse upper gracilis flap technique for medial breast tumours in small- and medium-sized breasts. Although Clough et al. [14] reported that superior pedicle mammoplasty and batwing mastopexy can result in satisfactory outcomes for the lower and upper inner quadrants, therapeutic mammoplasty is less suitable for small breasts, especially if ptosis is absent [15].

The proper treatment modality for medially located breast cancer in Asian women with small- and medium-sized breasts (breast volume < 500 mL) is rarely investigated. For many years, we have performed various volume replacement and displacement oncoplastic procedures according to breast size and resection volume for medially located breast cancer, for which reconstruction is challenging. Hence, we aimed to present algorithms for medially located breast cancer based on our 12-year surgical experience.

METHODS

A total of 113 patients (114 cases) who underwent breast reconstruction after BCS for medially located breast cancer between January 2007 and December 2019 at Kyungpook National University Hospital were retrospectively evaluated. Patients aged > 18 years who underwent breast reconstruction after partial mastectomy for medially located (upper and lower inner quadrants) breast cancer, those with breast cancer without systemic metastasis, and non-pregnant and non-breastfeeding patients were included.

Preoperative breast volume was measured using the Artec Eva three-dimensional (3D) scanner (Artec 3D Inc., Luxembourg). If a patient who decided to undergo BCS wanted immediate breast reconstruction, a breast surgeon and plastic surgeon were consulted regarding the breast reconstruction method first. Thereafter, the expected complications, expected scar range, and donor site morbidities were explained to the patient. Surgery-based oncoplastic reconstruction was performed at the Department of Plastic and Reconstructive Surgery directly after partial mastectomy at the Department of Breast Surgery by each single surgeon. According to the preoperative breast volume and tumour size predicted using preoperative imaging such as ultrasonography or magnetic resonance imaging (MRI), one or two surgical designs were performed before surgery. Immediately after BCS, the excised specimen weight was checked, and the breast reconstructive method was confirmed based on the tumour resection volume-to-preoperative breast volume ratio. The breast reconstructive method according to the tumour resection volume-to-preoperative breast volume ratio was decided based on aesthetically satisfactory experiences before 2007. But patients sometimes requested reconstruction methods (usually less invasive) other than those recommended by us for reasons such as scars, operation time, and donor site morbidities. In these cases, surgeries were performed in accordance with the patient's needs as much as possible.

For the patients with small- and medium-sized breasts, oncoplastic techniques, including the tennis racket and round-block techniques, were performed for breasts with small resection volumes (ratio < 10%–15%; small defects). For moderate resection volumes (10%–15% < ratio < 25%–30%; medium defects), a rotational flap was applied. In cases where deformities such as postoperative depression were a concern, reconstruction was performed using a perforator flap, including thoracodorsal artery perforator (TDAP) and anterior intercostal artery perforator (AICAP) flaps. For large resection volumes (ratio > 30%; large defects), the defect was covered with a latissimus dorsi (LD) flap (**Figure 2**). For large-sized breasts (breast volume > 500 mL), oncoplastic techniques were chosen for reduction mammoplasty, and the tennis racket, rotational flap, and LD flap techniques were chosen, depending on the volume of the preoperative breasts, resection volume ratio, and the patient's preference for the expected scarring, time of operation, donor site morbidities, and complications. Small, moderate, and large breast are 18, 86, and 10 cases, respectively.

Each patient's age, body mass index (BMI), diagnosis, preoperative breast volume, excised mass weight, and satisfaction score were evaluated. The patients responded to the Kyungpook National University Hospital Breast Reconstruction Satisfaction Questionnaire during their outpatient clinic visit 6 months after surgery, and their satisfaction was evaluated by analysing the satisfaction scores (**Table 1**) [16]. Complications such as infection, seroma, necrosis, and hematoma were diagnosed based on the patient's clinical symptoms at the time of hospitalisation and after discharge through the outpatient clinic, and additional imaging workups such as ultrasonography were performed if necessary. For all patients, the

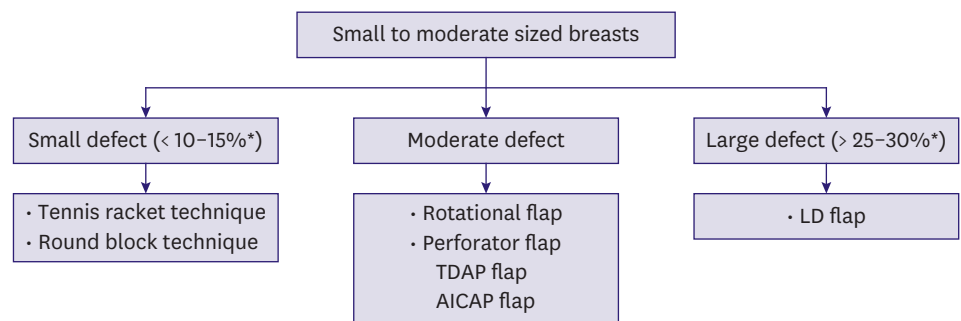


Figure 2. Algorithm for determining the oncoplastic breast surgery technique depending on the defect ratio in the medially located breast cancer.

TDAP = thoracodorsal artery perforator; AICAP = anterior intercostal artery perforator; LD = latissimus dorsi.

*Defect Ratio = Resection Volume/Breast Volume.

Table 1. The Kyungpook National University Hospital breast reconstruction satisfaction questionnaire

Question	Very satisfied	Satisfied	Neutral	Unsatisfied	Very dissatisfied
Q1. Overall satisfaction with my breast reconstruction	5	4	3	2	1
Q2. Symmetry of my breasts	5	4	3	2	1
Q3. Size of my reconstructed breast	5	4	3	2	1
Q4. Shape of my reconstructed breast	5	4	3	2	1
Q5. Feel to touch my reconstructed breast	5	4	3	2	1
Q6. Pain in my reconstructed breast	5	4	3	2	1
Q7. Scar of my reconstructed breast	5	4	3	2	1
Q8. Donor site pain	5	4	3	2	1
Q9. Donor site scar	5	4	3	2	1
Q10. Self-confidence	5	4	3	2	1
Q11. Sexual attractiveness	5	4	3	2	1

There are total 11 questions and scores from 1-5 according to the level of satisfaction.

follow-up period time was at least 5 years. For the statistical analysis, SPSS Statistics Version 26 (IBM Corp., Armonk, NY, USA) was used. The Kruskal-Wallis and Fisher exact tests were performed to compare the results of the surgical methods. The statistical significance level was set at $p < 0.05$.

The study was conducted in accordance with the Declaration of Helsinki. The study protocol was approved by the institutional review board (IRB) of Kyungpook National University Hospital (IRB File No. 2020-06-004). Written informed consent was obtained from the patients for the publication of this study and any use of accompanying images.

RESULTS

The median age of the patients was 49 years (range, 31–67 years), and the median follow-up duration was 31 months (range, 12–50 months). The diagnoses were invasive ductal carcinoma (IDC), ductal carcinoma *in situ*, invasive lobular carcinoma, papillary carcinoma, mucinous carcinoma, and microinvasive ductal cancer in 91 (78.82%), 17 (14.9%), 3 (2.63%), 1 (0.87%), 1 (0.87%), and 1 (0.87%) cases, respectively. The mean specimen weight was 83.29 g (range, 15–290 g). After surgery, radiotherapy, chemotherapy, and hormone therapy were performed in 88 (77.19%), 74 (64.91%), and 81 (71.05%) patients, respectively. The mean BMI was 23.43 kg/m². All patients were Korean women and none of them were smokers.

Of the 103 patients (104 cases) with small- and medium-sized breasts (breast volume < 500 mL), tennis racket, round block, rotational flap, AICAP, TDAP and LD flap techniques were applied in 25 (24.03%), 5 (4.80%), 29 (27.88%), 4 (3.84%), 7 (6.73%) and 34 (32.6%) cases, respectively. Reduction mammoplasty was not performed any patients. There were no significant differences of age between groups, respectively. The excised mass weights and mass to breast ratio in the surgical groups showed significant differences between groups, respectively.

In patients with small- and medium-sized breasts, the complications consisted included hematoma (n = 1/104, 0.96%), linear skin necrosis (n = 1/104, 0.96%), and seromas (n = 8/104, 7.69%) in the LD flap group; fat necrosis (n = 2/104, 1.92%) in the rotational flap group; and fat necrosis (n = 1/104, 0.96%) in the AICAP flap group. The hematoma improved with conservative treatment, and the seroma improved after aspiration. The skin and fat necrosis improved after revision and pharmacological treatment, respectively (Table 2). In the satisfaction surveys, 91 patients (87.5%) reported answers of “excellent” and “good”, respectively (Table 3).

For the large breasts (10 cases), the oncoplastic reduction, rotational flap, tennis racket, and LD flap techniques were applied in 5 (50%), 3 (30%), 1 (10%), and 1 (10%) cases, respectively. No patients with large-sized breasts underwent partial breast reconstruction with the round block, AICAP flap, or TDAP flap techniques. One patient developed fat necrosis in the rotational flap, which was resolved with pharmacological treatment. In the satisfaction surveys, the score was the highest in the reduction mammoplasty group (Table 4). All the complications were treated

Table 2. Demographics and complications in patients with small- and medium-sized breasts

Reconstructive technique	Tennis racket	Round block	Rotational flap	AICAP	TDAP	LD	Reduction mammoplasty	p
Cases	25	5	29	4	7	34	0	
Age (yr)	45.5 ± 7.6	47.2 ± 11.4	47.1 ± 8.6	42.5 ± 4.7	47.3 ± 6.7	45.1 ± 5.7	-	0.859
BMI (kg/m ²)	23.6 ± 3.2	20.3 ± 1.5	23.9 ± 2.9	21.8 ± 1.7	24.6 ± 2.1	22.3 ± 1.8	-	0.006 [†]
Breast volume (mL)	360.5 ± 121.8	239.2 ± 49.7	343.8 ± 88.9	244.4 ± 17.3	331.9 ± 32.1	317.3 ± 84.7	-	0.024*
Excised mass weight (g)	54.6 ± 27.4	38.0 ± 4.9	76.4 ± 33.5	55.7 ± 16.0	76.8 ± 5.2	103.2 ± 40.8	-	< 0.001 [†]
Mass to breast ratio (%)	16.0 ± 7.6	16.4 ± 4.1	21.9 ± 5.9	22.9 ± 6.7	29.8 ± 4.1	33.6 ± 1s4.1	-	< 0.001 [†]
Smoker	0	0	0	0	0	0	-	
Comorbidities							-	
HTN	5	0	7	0	1	4	-	
DM	1	0	2	0	0	2	-	
Other	0	0	0	0	0	0	-	
No. of RTx							-	
Adjuvant	21	5	25	0	6	26	-	
Neoadjuvant	0	0	0	0	0	0	-	
No. of CTx							-	
Adjuvant	14	3	17	3	7	19	-	
Neoadjuvant	1	0	1	0	0	1	-	
No. of adjuvant HTx	18	3	23	4	3	26	-	
Complications						10	-	
Hematoma	0	0	0	0	0	1	-	
Seroma	0	0	0	0	0	8	-	
Infection	0	0	0	0	0	0	-	
Skin necrosis	0	0	0	0	0	1	-	
Fat necrosis	0	0	2	1	0	0	-	

Values are presented as mean ± standard deviation. We compared the values according to surgical techniques. And we investigated the complications as hematoma, seroma, infection, skin necrosis and fat necrosis.

AICAP = anterior intercostal artery perforator; TDAP = thoracodorsal artery perforator; LD = latissimus dorsi; BMI = body mass index; HTN = hypertension; DM = diabetes mellitus; RTx = radiotherapy; CTx = chemotherapy; HTx = hormone therapy.

*p < 0.05; †p < 0.01.

Table 3. Satisfaction scores in patients with small- and medium-sized breasts

Characteristics	Cases	No. (%)			
		Excellent	Good	Fair	Poor
Tennis racket	25	14 (56.0)	8 (32.0)	3 (12.0)	0
Round block	5	3 (60.0)	1 (20.0)	1 (20.0)	0
Rotational flap	29	17 (58.6)	9 (31.0)	3 (10.3)	0
AICAP	4	3 (75.0)	1 (25.0)	0	0
TDAP	7	4 (57.1)	2 (28.6)	1 (14.3)	0
LD	34	11 (32.4)	18 (53.0)	5 (14.7)	0
Reduction mammoplasty	0	-	-	-	-

Values are presented as number (%). We check the scores by Kyungpook National University Hospital breast reconstruction satisfaction questionnaire, and compared by the surgical techniques.

AICAP = anterior intercostal artery perforator; TDAP = thoracodorsal artery perforator; LD = latissimus dorsi.

with minor revision or aspiration, and no further flap loss or infection was observed. We have presented three representative cases of breast reconstruction for small- and medium-sized breasts after partial mastectomy in accordance with our strategy.

Case 1

A 48-year-old patient presented with a microcalcification in the right breast during an early check-up. Ultrasonography revealed a 2.9-cm mass in the 3 o'clock position (upper inner quadrant). Follow-up core-needle biopsy confirmed the IDC. Consequently, partial mastectomy (91 g, ratio: 22.7%, medium defect) was performed, immediately followed by the rotational flap procedure. During the 7-year follow-up, the patient had no notable complications or tumour recurrence (**Figure 3**).

Table 4. Demographics and complications in patients with large breasts

Reconstructive technique	Tennis racket	Round block	Rotational flap	AICAP	TDAP	LD	Reduction mammoplasty
Cases	1	0	3	0	0	1	5
Age (yr)	49	-	44.3 ± 7.0	-	-	53	49.6 ± 7.3
BMI (kg/m ²) (mean±SD)	33.7	-	24.5 ± 2.7	-	-	22.6	27.0 ± 3.0
Breast volume (mL)	520.0	-	573.3 ± 110.2	-	-	500.0	666.0 ± 164.0
Excised mass weight (g)	160.0	-	127.0 ± 20.2	-	-	135.0	155.6 ± 90.4
Smoker							
Comorbidities							
HTN							
DM							
Other							
Patient's satisfaction	4.5	-	4.5 ± 0.1	-	-	4.4	4.7 ± 0.2
No. of RTx							
Adjuvant	1	-	1	-	-	1	4
Neoadjuvant	0	-	0	-	-	0	0
No. of CTx							
Adjuvant	1	-	3	-	-	0	4
Neoadjuvant	0	-	0	-	-	0	0
No. of adjuvant HTx	0	-	2	-	-	1	2
Complications							
Hematoma	0	-	0	-	-	0	0
Seroma	0	-	0	-	-	0	0
Infection	0	-	0	-	-	0	0
Skin necrosis	0	-	0	-	-	0	0
Fat necrosis	0	-	1	-	-	0	0

Values are presented as mean ± standard deviation. We compared the values according to surgical techniques and we investigated the complications as hematoma, seroma, infection, skin necrosis and fat necrosis same as in patients with small- and medium sized breasts.

AICAP = anterior intercostal artery perforator; TDAP = thoracodorsal artery perforator; LD = latissimus dorsi; BMI = body mass index; HTN = hypertension; DM = diabetes mellitus; RTx = radiotherapy; CTx = chemotherapy; HTx = hormone therapy.

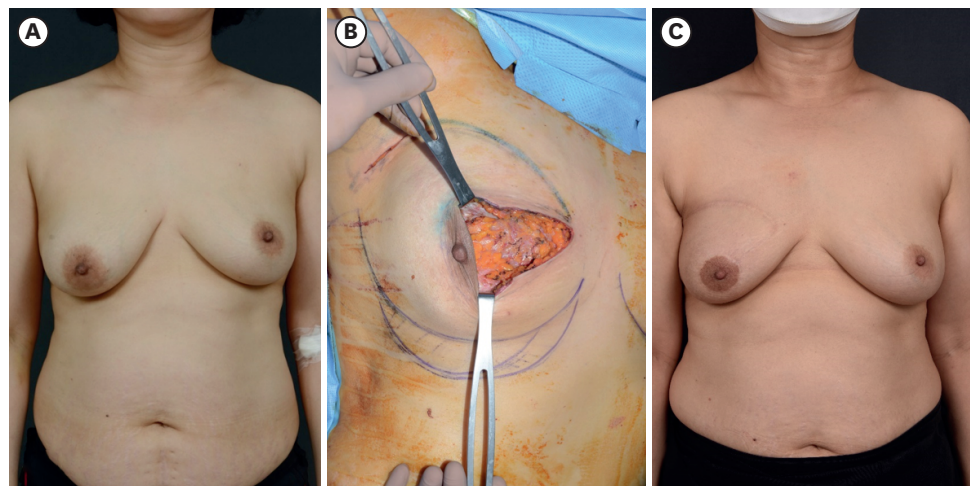


Figure 3. (A) Preoperative photograph. (B) Intraoperative finding of a breast defect after breast-conserving surgery. (C) Seven months after operation.

Case 2

A 47-year-old patient presented with a microcalcification in the left breast during an early check-up. Ultrasonography revealed a 2.6-cm mass in the 10 o'clock position (upper inner quadrant). A follow-up core-needle biopsy confirmed the IDC. Therefore, partial mastectomy of the left breast (63 g, ratio: 20%, medium defect) and the TDAP flap procedure were concurrently performed. During the 8-year follow-up, the patient had no notable complications or tumour recurrence (**Figure 4**).

Case 3

A 47-year-old patient presented with a microcalcification in the left breast during an early check-up. Ultrasonography revealed a 1.6-cm mass in the 8 o'clock position (lower inner quadrant). A follow-up core-needle biopsy confirmed the IDC. Therefore, partial mastectomy of the right breast (40 g, ratio: 19.04%, medium defect) and the LD flap procedure were concurrently performed. During the 3-year follow-up, the patient did not exhibit any notable complications or tumour recurrence (**Figure 5**).

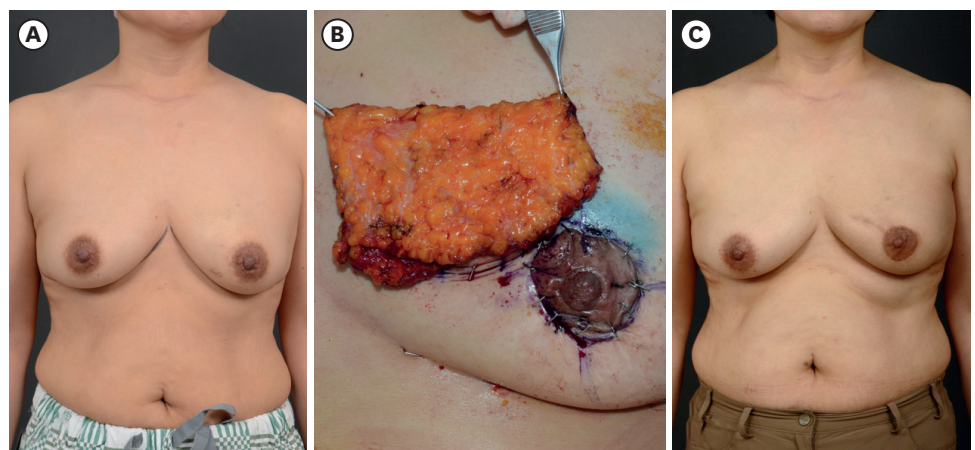


Figure 4. (A) Preoperative photograph. (B) Intraoperative finding of a breast defect after breast-conserving surgery. (C) Two years after operation.

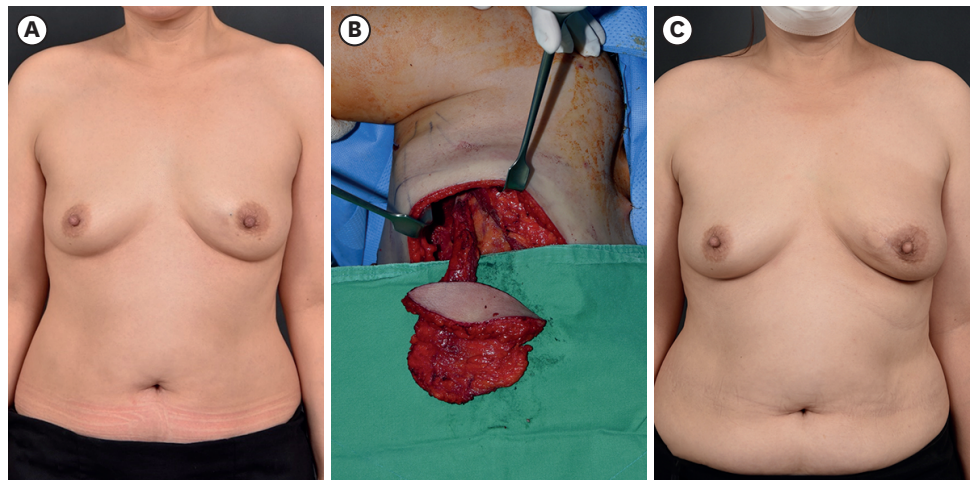


Figure 5. (A) Preoperative photograph. (B) Intraoperative finding of a breast defect after breast-conserving surgery. (C) Two years after operation.

DISCUSSION

The medial area of breast is an extremely difficult location to access owing to the lack of excess skin and glands, risk of visible scarring, and likelihood of NAC dislocation [9]. Tumour location is an important factor for cosmetic outcomes [4]. Regarding Western patients with large-sized breasts, Kronowitz et al. [5] introduced reconstruction methods such as reduction mammoplasty for a medial region defect, presenting possible surgical techniques for each location of the breast. Clough et al. [14] reported that reduction mammoplasty showed good results in patients with breast ptosis. Similarly, we attained satisfactory outcomes using the oncoplastic reduction technique; however, this technique is difficult in Asian patients, who tend to have small- and medium-sized breasts [3].

The senior author selected the partial breast reconstruction method according to the breast defect ratio after BCS for patients with medially located breast cancer with a breast volume of < 500 mL. We are not presenting a novel surgical method, but through this retrospective study, we could consider the conclusion that our surgical algorithm yields good cosmetic results without many complications.

In the small- and medium-sized breast patient group, the mean breast volume, BMI, and number of radiotherapies were statistically different between the surgical methods. Only a small number of patients underwent the round-block, AICAP flap, and TDAP flap techniques, which possibly affected the outcome. When only the tennis racket, rotational flap, and LD techniques were analysed, no significant differences in BMI and radiotherapy were found ($p > 0.05$). Regarding patient satisfaction results, most of the patients scored 4 or 5 in each of the categories, and the mean score for some perforator flaps (TDAP and LD) applied on the donor site scar was slightly lower than that for the other techniques. Of the patients who underwent the volume displacement techniques (tennis racket and round block), some patients reported relatively poor symmetry and size scores than others possibly because relatively simple volume displacement surgery was performed in accordance with the patient's intention despite the high defect ratio. Hence, we thought that the mean satisfaction score for volume displacement surgery was lower than that for other surgeries. Nevertheless, the overall score was > 50, indicating high aesthetic satisfaction.

We have previously introduced various volume replacement techniques that can be applied in oncoplastic breast surgery for patients with breast cancer who have small- and medium-sized breasts [17]. However, several regional flap techniques could not be performed in medially located defects owing to physical limitations such as limited pedicle vessel length. Regarding perforator flaps, an AICAP flap could only cover the lower quadrant, and a TDAP flap could only cover the upper quadrant.

Among the surgical techniques mentioned herein, the rotational flap technique is a reconstruction method performed by rotating a flap containing skin and subcutaneous tissues [18]. It has the characteristics of volume displacement and replacement in that the adjacent breast tissue can be adjusted during rotation and concurrent rotation of the surrounding axillary tissue adjacent to the breast can supplement the postoperative breast volume. As an extension of this concept and volume displacement for small defects and volume replacement for medium-to-large defects, the rotation flap technique was selected for medium defects in this study.

With myocutaneous flaps, including the LD flap, the muscle volume decreased over time, reducing the size of the reconstructed breast. Lee et al. [19] reported that the myocutaneous flap volume decreased after surgery. Similarly, postoperative volume reduction, which led to poor aesthetic outcomes, occurred after defect reconstruction using the volume replacement technique in this study. Accordingly, the reconstruction of defects with larger breast volume than that of the opposite breast could result in a symmetrical appearance through postoperative volume reduction. There were some complications with the LD flap, occurred in approximately 29.4% (10/34) cases, most of which were seroma (incidence rate: approximately 23.5% [8/34]). In breast reconstruction using a LD flap, donor site seroma was the most common complication; considering that its incidence is 6%–80% [20], this is a reasonable result.

Munhoz et al. [12] discussed possible surgical techniques for medium-sized defects in small- and medium-sized breasts in terms of the lateral and central/medial quadrants. They concluded that the volume replacement technique can produce superior aesthetic outcomes for coverage of defects in the central/medial quadrant. Cochrane et al. [4] reported that volume replacement should be considered when the resection volume-to-breast volume ratio is high. Although the volume displacement technique can lead to good cosmetic outcomes in Western patients who have relatively large-sized breasts [14], it has limitations for medial area defects in patients with small- and medium-sized breasts [21].

Several studies have been conducted to address this problem. Lin et al. [6] reported that the matrix rotation flap technique is effective for reconstruction of defects in the upper inner quadrant. Lee et al. [8] demonstrated the effectiveness of the fish-hook incision rotation flap technique for defects in the inner quadrant. Zaha [22] reported the use of an omental flap for defects in the upper inner quadrant. These studies verified that the reported surgical techniques can be effective for the reconstruction of inner quadrant defects.

We selected oncoplastic techniques based on not only the excised specimen weight but also the excised volume-to-breast volume ratio in medially located breast cancer and obtained good overall outcomes. For Asians, who tend to have small- and medium-sized breasts, various oncoplastic volume replacement techniques are useful for reconstruction, except for cases with small defects (ratio < 10%–15%) [3,23].

This study has some limitations. First, because this was a retrospective study, selection bias was possible. In Korea, reconstruction after partial mastectomy is not covered by the national health insurance, so patients are burdened with cost. Therefore, there is a possibility that more patients who have purchased additional private insurance or have sufficient economic capacity have undergone surgery and have been included in this study. Since the economic level and health management such as hospital visits are closely related, a healthy user bias may have occurred. Second, the result of cosmetic outcomes was based on patients' satisfaction score. Some patients who wished for less invasive surgery would have given an informed consent about the possibility of postoperative deformity. In this part, patients' expectations may be lowered and bias may have occurred. For an objective evaluation we can plan a quantitative analysis for volume differences with MRI, mammography and 3D scanners. Breast asymmetry can be quantitatively analyzed by measuring the length between several parameters, such as width, height and projection of breasts, the change in the location of NAC and the distance from the inframammary fold line with 3D scanners. The most important thing in the cosmetic outcome is the patient's own satisfaction, but if the quantitative analysis methods are added and compared to the subjective satisfaction score of the patient, more objective evaluation would be possible. Third, the number of patients in some surgical groups were small; hence, additional studies with larger numbers are needed. Fourth, the Korean women included in our study had denser breasts than Caucasian women [24]; hence, their breast density may also be different from that of other races. However, the overall outcome of the different surgical methods depending on the defect ratio may be generalised to all races. To confirm this, further research must be conducted in various races.

In conclusion, for breast cancer located in the upper and lower medial quadrants, our algorithm for determining the appropriate surgical technique based on breast size and resection volume could provide useful algorithms for the selection of immediate oncoplastic breast surgery techniques after BCS.

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